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ABSTRACT

Two experiments examined developmental trends in children's lexical decisions for abstract and concrete words. The first experiment examined children's on-line comprehension of abstract and concrete words. Subjects were 15 second or third graders and 15 college adults at the University of Georgia. The second experiment provided a stronger test of the finding that children relied more than adults did on sensory, imaginal information in making lexical decisions. Subjects were 48 people from a rural Georgia public school system--a mix of children and adults. In both experiments, third-grade children's lexical decisions seemed to reflect the tendency to retrieve sensory/imaginal information, whereas adults and fifth-grade children's decisions seemed to reflect the use of readily available contextual information from prior knowledge. Findings suggest that there is a developmental shift in the kinds of semantic characteristics that are readily available to children in making lexical decisions. Two tables of data are included. (Contains 41 references.) (Author/RS)

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Developmental Trends in Lexical Decisions for Abstract and Concrete Words

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Abstract. Two experiments examined developmental trends in children's lexical decisions for abstract and concrete words. Each experiment examined developmental changes in the reliance on various kinds of information associated with abstract and concrete words in making lexical decisions. In all experiments, third-grade children's lexical decisions seemed to reflect the tendency to retrieve sensory/imaginal information, whereas adults and fifth- grade children's decisions seemed to reflect the use of readily available contextual information from prior knowledge. It is concluded that there is a developmental shift in the kinds of semantic characteristics that are readily available to children in making lexical decisions.

Understanding the development of children's ability to comprehend abstract and concrete words is essential for understanding their semantic processing during reading. Concrete words have direct sensory referents whereas abstract words do not. Considerable evidence suggests that concreteness represents a fundamental semantic distinction among words. In large factor analyses, concreteness has invariably emerged as an important variable affecting word recognition (DiVesta & Walls, 1970; Paivio, 1968; Rubin, 1980). Yet, most current theories of semantic development and reading comprehension do not directly address concreteness as a distinguishing characteristic of words. The purpose of the present paper is to explore children's on-line comprehension of abstract and concrete words to evaluate how their understanding of these word types might change over time.

In general, adults find abstract words harder to understand than concrete ones. Well-controlled studies of sentence comprehension show that, in general, sentences composed of abstract words take longer for adults to understand than sentences composed of concrete words (Haberlandt & Graesser, 1985; Holmes & Langford, 1976; Schwanenflugel & Shoben, 1983). The longer processing of abstract over concrete words is particularly evident when the processing of single abstract and concrete words is examined. Most researchers have found that abstract words take longer for adults to make lexical decisions for than concrete words (Bleasdale, 1987; deGroot, 1989; Howell & Bryden, 1987; James, 1975; Kroll & Merves, 1986, Experiment 2; Rubin, 1980; Schwanenflugel, Harnishfeger, & Stowe, 1988; Schwanenflugel & Shoben, 1983; Whaley, 1978; but see Gernsbacher, 1984; Kroll & Merves, 1986, Experiment 1; Richardson, 1976). These latter findings indicate that adults often retrieve word meanings in the process of making lexical decisions and that they retrieve the meanings of concrete words more easily than they do the meanings of abstract words.

There have been many attempts to explain the general processing superiority of concrete words in adults. Two of the more successful explanations have been the *dual-coding theory* (Paivio, 1986) and the *context availability hypothesis* (Kieras, 1978; Schwanenflugel, Harnishfeger, & Stowe, 1988). The dual-coding theory postulates the existence of two

structurally and functionally distinct representational systems: a verbal system (called the *logogen* system) and an image system (called the *imagen* system). These two systems can operate either together or separately in verbal processing. Concrete words are said to have stronger referential connections to the imagen system than abstract words have, although the verbal associative linkages are said to be similar for the two word types (Paivio, 1986, p. 128). The theory is unclear whether concreteness affects comprehension and exactly what effect might be expected if it did. Because of the general finding of a concreteness superiority in lexical decisions and sentence comprehension, Paivio concluded that "...referential and associative imagery reactions are more likely to be part of the comprehension of concrete than abstract material" (Paivio, 1986, p. 218). These effects of imagery reactions are said to be additive above and beyond those of the verbal processes. Thus, the superiority in lexical processing of concrete over abstract words is attributed to the greater availability of the imagen system for concrete than abstract words.

In contrast, the context availability theory, as described by Schwanenflugel and her colleagues (cf. Schwanenflugel, 1991; Schwanenflugel et al., 1988; Schwanenflugel & Shoben, 1983; Schwanenflugel & Stowe, 1989), attributes concreteness effects in on-line comprehension to the ease with which information is retrieved from prior knowledge in general without emphasizing the special status of sensory information. This view suggests that abstract words are more difficult to understand than concrete words because people experience greater difficulty in retrieving from prior knowledge relevant information about abstract words. According to this view, supportive stimulus contexts can help override this difficulty for abstract words by making the information necessary for comprehension more available to the reader. Thus, when information is readily available from a reader's knowledge base or when the information is made available to the reader through priming by a supportive context, comprehension should proceed quickly for both abstract and concrete words. This prediction has been supported by several studies, which showed that when abstract and concrete words are presented in supportive contexts, lexical decisions, naming times, and sentence meaningfulness judgment times for abstract and concrete words do not differ (Schwanenflugel et al., 1988; Schwanenflugel & Shoben, 1983; Schwanenflugel & Stowe, 1989). In other studies, subjects have been asked to rate words on the ease with which they can think of a context or circumstance for each word. When abstract and concrete words are rated as similarly easy to retrieve contextual information from prior knowledge for, lexical decisions for them do not differ (Schwanenflugel et al., 1988). Thus, these studies obtained evidence that in making lexical decisions for abstract and concrete words, adults rely on the retrieval of *any* readily available information from prior knowledge rather than simply sensory, imaginal information.

To date, few studies have examined the on-line processing of abstract and concrete words in children. Vocabulary studies suggest that as a group, abstract words take longer than concrete words to enter children's speaking and reading vocabularies (Brown, 1957; Kiraly & Furlong, 1974; Schwanenflugel, 1991; Yore & Ollila, 1985; but see Richmond & McNinch, 1977). Moreover, children are less accurate in reading abstract words (Coltheart, Laxon, & Keating, 1988). However, these studies do not tell us much about the processing of common abstract words that children *do* know. We do not know whether children process abstract words differently from adults. As noted earlier, adults also show concreteness advantages in reading abstract and concrete words. The finding of a similar advantage in children may simply reflect the same processes that operate in adults.

The purpose of the present series of studies was to investigate children's comprehension of abstract and concrete words by examining developmental trends in lexical decisions for these word types. Lexical decision was used because lexical decisions are highly affected by semantic information (Balota & Chumbley, 1984; Balota & Lorch, 1986; Chumbley & Balota, 1984; Forster, 1981). Lexical decision times reflect both a lexical access component and a decision component (Seidenberg, Waters, Sanders, & Langer, 1984). Apparently, semantic information is retrieved as part of the decision component. For adults, the concreteness effects displayed in lexical decisions are relatively large and are similar to those displayed in comprehension tasks such as meaningfulness judgments (Schwanenflugel & Stowe, 1989). Thus, if we are interested in assessing the influence of semantic

information on children's comprehension of single words, lexical decision is a reasonable task to use. In each experiment, we examined children's reliance on various kinds of semantic information associated with abstract and concrete words.

EXPERIMENT 1

The purpose of Experiment 1 was to examine children's on-line comprehension of abstract and concrete words by examining their lexical decisions for common abstract and concrete words. As noted earlier, adults have been shown to display longer lexical decision times for abstract words than concrete words (Bleasdale, 1987; deGroot, 1989; James, 1975; Howell & Bryden, 1987; Rubin, 1980; Schwanenflugel & Shoben, 1983; Schwanenflugel et al., 1988; Whaley, 1978; but see Gernsbacher, 1984; Richardson, 1976). The fact that adults take longer to make lexical decisions for abstract words than concrete words (even for words of similar length and frequency) suggests that adults have more difficulty retrieving semantic information useful in making lexical decisions for abstract words. Thus, the focus of the present experiment was to compare children's understanding of abstract and concrete words with that of adults.

Method

Design. A 2 × 3, age group (children versus adults) by word imageability (low, medium, and high) design was used, with age as a between-subjects factor and word imageability as a within-subjects factor.

Subjects. Subjects were 15 second or third graders (mean age = 7 years, 11 months) and 15 adults. The children were participants in a Saturday morning enrichment program for the intellectually and artistically talented at the University of Georgia. Because entrance to the program is generally based on teacher referrals, no IQ or standardized reading measures were available for children participating in the study. However, students in this program typically range from above average to superior in intellectual performance for their age. The adults were 15 college students who were fulfilling a requirement for an introductory psychology course.

Stimuli. The abstract and concrete words selected for the study (a) had a frequency of 9 per million or greater according to the word frequency index assembled by Carroll, Davies, & Richman (1971) for their third-grade corpus, and (b) could be found in the Paivio, Yuille, & Madigan (1968) set of abstract and concrete words. Fifteen high, 15 medium, and 15 low imageability words were selected that varied in rated imageability (high: $M = 6.38$, $SD = .20$; medium: $M = 4.30$, $SD = .55$; low: $M = 2.82$, $SD = .41$), but that were as close as possible in word frequency (as defined by the third-grade corpus) (high: $M = 40$, $SD = 46$; medium: $M = 35$, $SD = 37$; low: $M = 38$, $SD = 42$) and word length in letters (high: $M = 5.73$, $SD = .96$; medium: $M = 6.00$, $SD = 1.56$; low: $M = 6.20$, $SD = 1.57$).

In addition to the experimental word stimuli, 45 nonword stimuli were constructed by selecting other words from the third- grade corpus and changing each of them by one letter so that they no longer represented words. Sixteen practice trials similar to the experimental stimuli were also constructed: 8 word trials and 8 nonword trials.

Procedure. All stimuli were presented in upper case letters on an Apple IIe computer monitor in the center of the computer screen. On the computer keyboard, "yes" and "no" keys were labeled. The procedure for all trials was as follows: First, a "READY?" signal appeared on the computer screen. When the subjects pressed the space bar of the computer keyboard to start the trial, the signal disappeared from the screen, and the lexical decision item appeared one space to the right of where the signal had been. Subjects were told to decide as quickly as possible whether or not the item appearing on the screen was a word, and then record their decision by pressing either the "yes" key or the "no" key on the computer keyboard. They were instructed to press the "no" button if they did not know whether a particular item was a word or not. If subjects pressed a button other than the correct one, a "RESPONSE IS INCORRECT" signal appeared on the screen for one second. At the end of each trial, the "READY?" signal reappeared, allowing the subject to rest or to proceed with the next trial.

Each subject completed 106 trials: 16 practice and 90 experimental. Trials were presented in a different order for each subject. Subjects were run in groups of up to three children, but each child had a private

booth. The experimental session was completed in approximately 20 minutes.

Results

Reaction times were considered the main dependent variable of interest. For all analyses, reaction times greater than 2 standard deviations above the mean of each condition were considered outliers and were scored as errors. Although error rates were also analyzed, the only significant finding for errors was that children made more errors than adults did, $F(1,28) = 14.97$. Therefore, errors will not be considered further. The overall mean lexical decision time for words (1103 ms) was 230 ms shorter than that for nonwords (1333 ms), but because these times had little theoretical importance in this experiment, they were not analyzed further. All analyses were significant at the .05 level unless otherwise indicated.

The means for lexical decision times for the high, medium, and low imageability words for children and adults can be found in Table 1. In order to compare children's processing of abstract and concrete words with those of adults, a 2 (age) X 3 (word imageability) analysis of variance (ANOVA) was performed, with age as a between-subjects factor and word imageability as a within-subjects factor. This analysis yielded significant main effects of age, $F(1,28) = 94.24$, and imageability, $F(1,28) = 7.83$. However, the most important finding was the significant interaction between age and imageability, $F(2,56) = 4.36$. The pattern of this interaction suggested that the imageability effect was much larger for children than it was for adults.

Given the interaction of word imageability with age, an analysis testing for a linear trend was performed, examining lexical decision times as a function of word imageability at each age. This trend was significant for both the children, $F(1,14) = 12.03$, and the adults, $F(1,14) = 6.76$. Thus, it appears that as word imageability decreases, lexical decision times increase for both adults and children, although this effect is much larger for children.

Correlational analyses. Correlational analyses were also performed to ascertain the degree to which different semantic variables may have affected the lexical decision times in children and adults. Previous research with adults suggested that context availability plays a larger role than word imageability in determining lexical decision times. Consequently, we asked 15 adults to rate the items we used in this study for context availability, using the instructions reported in Schwanenflugel et al. (1988). The context availability instructions asked subjects to rate the words according to the ease with which they could think of a context or circumstance in which the word could appear, using a 1 if it was "very hard" to think of a context or circumstance and a 7 if it was "very easy" to think of a context or circumstance. These context availability ratings were used as an index of the ease with which the person could retrieve from prior knowledge some information related to the word. The imageability ratings for the same words were taken from the Paivio et al. (1968) norms for use as an index of the ease with which sensory/imaginal information could be retrieved for the words. In the imageability rating instructions, a rating of 1 represented difficulty in retrieving or creating an image for the word and a 7 represented ease. These context availability and imagery ratings were used as predictors of mean lexical decision times for the words in the study.

Table 1. Mean lexical decision times in milliseconds (and percentage of errors) for Experiment 1

Age Group	Word Imageability		
	High	Medium	Low
Children	1428	1510	1649
	(17.0)	(12.1)	(17.9)
Adults	662	673	694
	(6.7)	(3.6)	(4.5)

To examine the degree to which semantic factors could account for lexical decision times, we first controlled for two nonsemantic factors known to be associated with lexical decision time by partialing out the correlation between lexical decision time, word length, and word frequency. With these nonsemantic variables partialed, imageability ratings were significantly correlated with children's lexical decision times ($r = -.51$) and those of adults ($r = -.28$). However, context availability ratings were significantly

correlated with adult judgments (r = -.34), but not with children's (r = -.20, p > .10), suggesting that adults relied more than children did on the relative availability of information from prior knowledge. This conclusion was supported further by the finding that, when context availability was partialled, imageability remained significantly correlated with children's lexical decision times (r = -.48), but not with adults' (r = -.17, p > .05). Moreover, when imagery was partialled from lexical decision times, the correlation of adults' times with context availability remained significant (r = -.26), as had been shown in earlier research (Schwanenflugel et al., 1988; Schwanenflugel & Shoben, 1983).

This pattern of results suggests that the large concreteness effects in children's lexical decision times were largely attributable to word imageability, whereas the effects for adults were largely attributable to context availability. Thus, it appears that, in making lexical decisions, children rely more on the sensory aspects of word meanings, but adults use any readily available information from prior knowledge. These findings suggest that children and adults use different information in making lexical decisions.

EXPERIMENT 2

Experiment 2 was designed to provide a stronger test of the finding (noted in Experiment 1) that children rely more than adults do on sensory, imaginal information in making lexical decisions. A set of abstract and concrete words controlled for rated context availability was contrasted with a similar set of words for which concreteness was confounded with context availability. Schwanenflugel et al. (1988) have shown that adults do not take longer to make lexical decisions for abstract words than concrete words when the words are controlled for rated context availability. Their finding suggested that adults are likely to use highly available information from prior knowledge to assist in the lexical decision process and that they do not rely on the specific retrieval of sensory characteristics of the words in making these decisions. If children are more likely than adults to rely on the retrieval of sensory information in making lexical decisions, then it would be expected that they would continue to display concreteness effects even when the availability of information from prior knowledge has been controlled for by controlling for rated context availability. Experiment 2 consisted of two related studies designed to examine this issue.

In Experiment 2A, items were selected for conditions on the basis of ratings obtained from adult subjects. In Experiment 2B, items were selected on the basis of ratings obtained from children.

Experiment 2A

Method

Design. A 3 × 2 × 2, age (third graders, fifth graders, and adults) by context availability by word imageability design was used. Age was a between-subjects factor. Context availability and word imageability were within-subjects factors.

Subjects. Forty-eight people from a rural public school system in Georgia participated in the lexical decision portion of the experiment: 16 subjects from the third grade (mean age = 9 years, 3 months), 16 from the fifth grade (mean age = 11 years, 0 months), and 16 teachers and staff members from the same public school system. None of the children were enrolled in special education programs; none had repeated a grade; and all had parental permission to participate. All 48 subjects were native English speakers.

Stimuli. Finding a set of words that were controlled for rated context availability involved two phases: (a) a normative rating phase and (b) an item selection phase.

In the normative phase, a set of 48 words was assembled from the word norms collected by Schwanenflugel et al. (1988). These words were equally divided between abstract and concrete words and covered a wide range of the context availability ratings from that study. To make it likely that the children were familiar with each word, all selected words had a frequency of at least 5 per million according to the Carroll et al. (1971) third-grade corpus.

For the rating tasks, instructions for imageability and context availability were constructed, based on instructions previously reported in comparable adult rating studies. These instructions were re-written slightly to be understandable to children participating in the experiment, but yield ratings comparable to those for adults reported in Schwanenflugel et al.

(1988). The imagery instructions were a composite of the imageability and concreteness instructions reported in Paivio et al. (1968) and asked subjects to give a word a high concreteness rating (7) if they found it "easy to think of a picture" for the word and a low concreteness rating (1) if they found it "difficult to think of a picture" for the word. The context availability instructions asked subjects to rate the words according to the ease with which they could think of a setting or case for each word, using a 7 if it was "very easy to think of a case, circumstance or setting" for the word and a 1 if it was "very hard to think of a case, circumstance, or setting" for the word. Overall, these instructions yielded ratings very similar to those found by Schwanenflugel et al. (1988). The mean ratings correlated .91 for imageability and .94 for context availability with the ratings from Schwanenflugel et al. (1988).

In the item selection phase, 5 abstract and 5 concrete items were selected that were controlled as closely as possible for mean rated context availability (abstract: $M = 5.1$; concrete: $M = 5.3$), but that varied maximally in terms of word imageability (abstract: $M = 4.0$; concrete: $M = 6.1$). These items were as close as possible in word length in letters (abstract: $M = 6$; concrete: $M = 6$) and word frequency (abstract: $M = 21$; concrete: $M = 22$), as defined by the third-grade corpus of Carroll et al. (1971).

An additional 5 abstract and 5 concrete items were selected that were confounded for rated context availability but were otherwise as similar as possible to those used in the controlled condition. These items differed in rated context availability (abstract: $M = 4.9$; concrete: $M = 6.0$) and imageability (abstract: $M = 4.0$; concrete: $M = 6.1$), but were as similar as possible in word length (abstract: $M = 7$; concrete: $M = 6$) and in word frequency (abstract: $M = 32$; concrete: $M = 26$). Therefore, abstract and concrete words in the context-availability-confounded condition differed from those in the context-availability-controlled condition mainly in the relationship between imageability and context availability.

A matching set of 20 nonword trials was constructed from words not used in the norms. These words were each changed by one letter so that they no longer represented words. Forty practice trials were also constructed by selecting different words from the third- grade corpus of Carroll et al. (1971); 20 were words and 20 were nonwords. Thus, subjects completed a total of 80 trials, 40 practice and 40 experimental.

Procedure. The procedure was identical to that of the previous experiment except that subjects were run singly rather than in small groups.

Table II. Mean lexical decision time in milliseconds (and percentage of errors) for Experiments 2A and 2B

Relation of Imageability to Context Availability		Grade Level		
		Third	Fifth	Adult
		Experiment 2A		
Controlled	Abstract	1318 (12.5)	811 (7.8)	635 (7.5)
	Concrete	1092 (15.0)	869 (11.3)	657 (9.1)
Confounded	Abstract	1564 (10.0)	1191 (8.8)	661 (3.8)
	Concrete	1273 (8.8)	834 (5.0)	593 (2.5)
		Experiment 2B		
Controlled	Abstract	1269 (5.0)	900 (3.8)	
	Concrete	1053 (8.8)	845 (6.3)	
Confounded	Abstract	1433 (5.0)	1118 (5.0)	
	Concrete	1195 (7.5)	784 (6.3)	

Results and Discussion

Subject mean reaction times for each condition were considered the main dependent variable of interest. For all analyses, reaction times greater than 2 *SD* above the mean for each condition were considered outliers and were scored as errors. Error rates were also analyzed, but these never explicitly contradicted those of reaction times, so they will not be considered further. Overall mean lexical decision times for words (963 ms) was 242 ms shorter than for nonwords (1205 ms), $F(2,45)$

= 25.79, $p < .05$, and the interaction between age and word type was not significant, $F(2,45) = 2.36$, $p > .10$. Because nonwords had no theoretical importance for this experiment, they were not analyzed further. All of the following analyses are significant at the .05 level unless otherwise indicated.

The mean reaction times and error rates can be seen in Table 2. In order to examine whether word imageability effects in lexical decisions disappeared when rated context availability was controlled for in both children and adults, a 2 × 2 × 2, age by context availability relation by word imageability ANOVA was performed. This analysis yielded a significant main effect of age, $F(2,45) = 27.08$, context availability relation, $F(1,45) = 27.08$, and word imageability, $F(1,45) = 19.09$. There were significant interactions between context availability relation and age, $F(2,45) = 9.29$; word imageability and age, $F(2,45) = 4.29$; and word imageability and context availability relation, $F(1,45) = 10.54$. Of most interest, however, was the significant three-way interaction between context availability relation, word imageability, and age, $F(2,45) = 3.69$. The form of this interaction appeared to indicate that, as suggested earlier, young children are more likely to rely on the sensory characteristics of words in making lexical decisions, whereas older children and adults rely on the retrieval of *any* highly available information from prior knowledge.

To determine the source of this interaction, a 2 × 2, context availability by concreteness ANOVA was performed for each age level. For adults, the analysis revealed a significant interaction between context availability relation and concreteness, $F(1,15) = 11.11$. Planned orthogonal contrasts of the high and low imagery words showed a significant effect of word imageability in the confounded condition, $t(15) = 3.54$, but not in the controlled condition, $t(15) = 1.15$, $p > .10$. These findings replicated earlier research using adult subjects by showing that word imageability effects appear only when word imageability and context availability are correlated.

The findings for fifth-grade subjects resembled those for adults: the analysis showed a significant interaction between context availability relation and concreteness, $F(1,15) = 25.49$. Planned orthogonal contrasts for high and low imageability items indicated significant effects of word imageability when word imageability was confounded with context availability, $t(15) = 6.16$, but not in the controlled condition, $t(15) = 1.00$, $p > .10$. Thus, as was the case with the adult subjects, fifth-grade subjects were slower to make lexical decisions for low imageability than high imageability words only when word imageability was confounded with rated context availability.

The results for the third-grade subjects contrasted with those of the older children and adults in terms of the influence of imagery in each condition. A 2 × 2 word imageability by context availability relation ANOVA revealed that the interaction between these two factors was not significant, $F < 1$, $p > .10$. Moreover, planned orthogonal contrasts indicated at least marginally significant word imageability effects in both the controlled condition, $t(15) = 2.1$, $p < .10$, and the confounded condition, $t(15) = 2.8$, $p < .05$. Thus, third-grade subjects were slower to make lexical decisions for abstract words regardless of the words' relationship to rated context availability.

In sum, as for Experiment 1, it appears that the younger children relied on the retrieval of sensory, imaginal information in making lexical decisions whereas the older children and adults did not. Older children and adults appeared to rely on the retrieval of any readily available information from prior knowledge in making lexical decisions. This latter finding replicates earlier research using adults that showed that lexical decisions are more highly related to context availability ratings than they are to imageability ratings.

Experiment 2B

In Experiment 2B, the abstract and concrete words selected were controlled for rated context availability using ratings obtained from children at both grade levels. The purpose of this experiment was to test whether younger children's lexical decision times would be related to context availability when words were selected on the basis of ratings obtained from their own age group.

Method

Design. A 2 x 2 x 2, age (third-graders versus fifth-graders) by context availability relation (controlled versus confounded) by word imageability (high versus low) design was used.

Subjects. Subjects for the lexical decision portion of this study were 32 students from a rural public school system in Georgia, who had received parental permission to participate: 16 were from the third grade (mean age = 9 years, 4 months) and 16 from the fifth grade (mean age = 10 years, 11 months). In addition, 30 third graders (mean age = 8 years, 8 months) and 30 fifth graders (mean age = 11 years, 2 months) participated in the rating tasks (15 from each grade for the imageability rating tasks and 15 from each grade for the context availability rating tasks). None of these subjects participated in any special education classes and all were native English speakers.

Stimuli. The children rated the same set of words that the adults in the normative rating task had rated in Experiment 2A, using the same set of instructions. From these norms, abstract and concrete words similar to those used in the previous experiment were selected, using developmentally appropriate ratings. This procedure of selecting developmentally rated words meant that a somewhat different set of items was used for each grade level.

For the third-grade subjects, 5 abstract and 5 concrete words were selected that were controlled as closely as possible for rated context availability (abstract: M = 3.0; concrete: M = 2.8), word frequency (abstract: M = 26; concrete: M = 29), and word length in letters (abstract: M = 7; concrete: M = 7), but that varied in word imageability (abstract: M = 3.7; concrete: M = 5.3). A second set of 5 abstract and 5 concrete words was selected for the context availability-confounded condition. These words varied as much as possible in both rated context availability (abstract: M = 1.9; concrete: M = 2.9) and imageability (abstract: M = 3.7; concrete: M = 5.2), but were as close as possible in word frequency (abstract: M = 12; concrete: M = 13) and word length (abstract: M = 7; concrete: M = 6).

The same procedure was used to select items for the fifth- grade subjects. For the items in the context availability-controlled condition, 5 abstract and 5 concrete items were selected that were controlled as closely as possible for context availability (abstract: M = 3.7; concrete: M = 3.9), word frequency (abstract: M = 25; concrete: M = 23), and word length in letters (abstract: M = 6; concrete: M = 5), but that varied as much as possible in rated imageability (abstract: M = 4.0; concrete: M = 5.2). Another set of 5 abstract and 5 concrete words was selected for the context availability-confounded condition. These words were as close as possible in word length (abstract: M = 7; concrete: M = 6) and word frequency (abstract: M = 38; concrete: M = 37), but varied as much as possible in rated context availability (abstract: M = 3.5; concrete: M = 4.3) and imageability (abstract: M = 4.0; concrete: M = 5.2).

Procedure. Using the procedure from Experiment 2A, nonwords were constructed from the words in the norms not used as targets. The practice items from Experiment 2A were used again in this experiment. The procedure followed that of Experiment 2A also.

Results and Discussion

The same procedures for outliers and error rates used in the previous experiment were employed. Overall mean lexical decision time for words (1066 ms) was 301 ms faster than for nonwords (1367 ms), $F(1,30)$ = 6.37, but the interaction between age and word type was not significant, $F < 1$, $p > .10$. Consequently, the nonwords were not analyzed further.

The mean reaction times and error rates for each condition at each developmental level can be found in Table 2. To ascertain whether younger children relied more than older children on sensory, imaginal information in making lexical decisions, a 2 × 2 × 2, context availability relation by word imageability by age ANOVA was performed on reaction times and error rates. None of the analyses of error rates approached significance (all $p > .10$). The results of this analysis for reaction times yielded significant main effects of age, $F(1,30)$ = 7.18, context availability relation, $F(1,30)$ = 16.40, and word imageability, $F(1,30)$ = 27.68, as well as a significant two-way interaction between context availability relation and word imageability, $F(1,30)$ = 8.23. However, of most interest to the present study was the three-way interaction between context availability relation, word imageability, and age, $F(1,30)$ = 5.31. The form of this interaction appeared to indicate large and consistent concreteness effects for third graders, but concreteness effects related to the accessibility of information from prior knowledge for the older children.

To isolate the source of this three-way interaction, the significance of the 2 (context availability relation)

X 2 (concreteness) interaction was tested at each age level separately. For fifth-grade subjects, this interaction between context availability relation and word imageability was significant, $F(1,15) = 19.26$. Further planned orthogonal contrasts showed that lexical decision times were significantly slower for abstract words than concrete words in the confounded condition, $t(15) = 7.42$, but not in the controlled condition, $t(15) = 1.22$, $p > .10$. Thus, as in experiment 2A, the pattern of lexical decision times for abstract and concrete words suggested that fifth graders tend to rely on the retrieval of *any* relevant information from prior knowledge in making lexical decisions rather than on the sensory, imaginal nature of the words.

Third graders displayed a markedly different pattern in their processing of abstract and concrete words. Unlike for fifth graders, this context availability relation by concreteness interaction was not significant, $F < 1$, $p > .10$. Planned orthogonal contrasts showed that third graders took significantly longer to make lexical decisions for abstract words than concrete words, both when rated context availability had been controlled for, $t(15) = 2.94$, and when context availability was confounded with word imageability, $t(15) = 2.41$. Thus, third graders appeared to rely on the retrieval of sensory information in making lexical decisions.

Combined items analysis. It is important to show that the findings we obtained were not attributable to one or two items that we happened to select for each study. An analysis that displayed the same basic patterns whether item means or subject means were used would suggest generality over items as well as subjects. It was not sensible to perform such analyses for the individual studies by themselves because of the small number of items used per condition (only 5). However, because similar findings were obtained in both Experiments 2A and 2B, it seemed reasonable to combine the data from both third- and fifth-grade subjects for items analyses so that generality over items could be tested.

A 2 × 2 × 2 × 2, experiment (2A and 2B) by age (third versus fifth graders) by imageability (concrete versus abstract) by context availability relation (controlled versus confounded) ANOVA was performed on item reaction times and error rates. This analysis indicated significant main effects of experiment (F (1,64) = 7.36), age (F (1,64) = 144.47), imageability ($F(1,64) = 25.71$), and context availability relation (F (1,64) = 54.27). There was a significant interaction between imageability and context availability, $F(1,64) = 8.70$, such that the effects of imageability were larger when context availability was confounded with imageability than when it was controlled. Most important, and consistent with the findings of the subjects analyses, was a significant three-way interaction between age, imageability, and context availability, $F(1,64) = 10.19$. No other interactions or main effects were significant (all $p >$ .10). None of the analyses of errors were significant (all $p > .10$). Thus, the results of analyses over items support those of the analyses over subjects, showing that young children's lexical decisions display consistent imageability effects regardless of the items' context availability status, whereas older children's lexical decision times appear more reflective of context availability.

In sum, regardless of whether adult ratings or developmentally appropriate ratings were used in the construction of stimuli, the results of Experiment 2B resembled those of the Experiment 2A. Younger children's lexical decision times appeared to reflect an attempt to retrieve sensory, imaginal information that causes them to take longer to make lexical decisions for abstract words than concrete words. However, the older children's lexical decision times matched the pattern that would be expected if they were simply retrieving from prior knowledge *any* readily available information associated with the words.

GENERAL DISCUSSION

These experiments enabled us to gain knowledge regarding the kinds of information that children and adults retrieve when making lexical decisions. In three experiments, we have found that young elementary school children display a general trend toward making faster lexical decisions for concrete words than abstract words. Their lexical decision times were better predicted by imagery ratings than context availability ratings. However, older elementary school children and adults showed lexical decision times that were better predicted by context availability ratings. When context availability was controlled either statistically

(Experiment 1) or experimentally (Experiments 2A and B), there was no difference in decision times between abstract and concrete words. This latter finding replicates and extends the findings noted for adults in other studies (Schwanenflugel et al., 1988; Schwanenflugel & Stowe, 1989; Schwanenflugel & Shoben, 1983) to older elementary school children, but not to younger readers. Thus, young children, who can be said to be in an early stage of reading comprehension, appear to be retrieving somewhat different information for words than do their adult counterparts.

Discussions of children's understanding of abstract and concrete words frequently center on the development of imagery representations. For example, Piaget and Inhelder (1971) assert that young children rely on some form of imaginal representation, but only older children and adults have access to abstract representations. Piaget and Inhelder suggest that images evolve from a "static" form of imagery that appears around 2 years of age to a transformational type of imagery at about 7 or 8 years of age. Similarly, Pressley (1977) suggests that the use of self-generated, elaborative mediational imagery as a learning strategy develops between 5 and 8 years of age. Bruner (1966) discusses the development at about ages 5 through 8 of an iconic form of representation with which the child can represent the world in terms of images rather than actions. However, at about age 8, symbolic representations begin to override these perceptual, iconic representations and as the child matures to adulthood, increasingly supersede them. Thus, these theorists agree that early elementary school children have access to a simple, static form of imagery that is replaced by a capacity for more flexible use of imagery and abstract symbolic representations.

This position is made more explicit by Kosslyn (1980, 1981) who advocates a theory of representational development in which young children rely predominantly on imagery to access information stored in memory whereas older children rely increasingly on abstract verbal representations. The internal representation of memory is said to change over time, with the dominance of an imagery-based code of representation giving way to a verbal-based code of representation. Imaginal codes are said to be used when the learner has insufficient or poorly encoded information concerning the material to be learned or processed; imagery is seen as a tool that is used when the retrieval of information is either difficult or when few attributes have been encoded explicitly. With age, a reduction in the use of imagery in many processing tasks will occur, primarily because the amount and availability of general propositional knowledge associated with words increases. Although Kosslyn does not directly address the question of when this reliance on imagery begins to decrease, his experiments indicate that this shift away from imagery may occur at about age 10. Kosslyn (1980; Kosslyn & Bower, 1974) has reported findings showing that children are more reliant on imagery in accessing information for verbal materials and that increasing age brings more reliance on abstract verbal representations and a concomitant decrease in the need for imagery.

The developmental trends in lexical decisions revealed in this study can be interpreted in light of this representational shift view of the development of the representational system. We have noted a general shift from young children's lexical decisions being associated with imageability ratings to older children's and adults' decisions being associated with context availability ratings. It is likely that the younger children relied on the retrieval of imagery to make their lexical decisions whereas older children and adults could apply other kinds of highly available information from their prior knowledge base in the decision process. That is, it is likely that imageability ratings provide an index of the availability of sensory/imaginal information and that context availability ratings reflected the availability of other, general knowledge associated with the words. The context availability rating instructions specifically asked subjects to assess the ease with which they could think of a case, circumstance, or setting for an individual word. This is the sort of general propositional knowledge that would be applicable to a verbal code. Thus, the trend toward reliance on context availability with increasing age might be taken as further evidence of this representational shift.

On the other hand, our experiments provide no evidence that children (and adults) possess distinct long-term memory codes. In fact, such evidence is extremely difficult to obtain (Anderson, 1978). Our results can also be explained in terms of a general shift in the relative proportion and automaticity of various types of information that children encode with age. Similar results would also be predicted if one made the more limited claim that younger children primarily

encode the meanings of words in terms of their sensory features and may only come to encode other types of information later, perhaps as regularities of use become evident and automatized through various communication contexts.

Adults possess varied information associated with abstract and concrete words, information that they have gathered through many episodic, contextual uses of words. Moreover, they can use this information flexibly to meet task goals (Schwanenflugel, Akin, & Luh, 1992). Thus, they can be directed toward using information relevant for forming images on some occasions and toward using the readily accessible information associated with context availability ratings on others. In lexical decisions, because of the task emphasis on speed, adults seem to rely on only the most available information that context availability ratings assess.

From these studies, it is clear that younger children have greater automatic access to the sensory characteristics of words than to words' other characteristics. Thus, as in Kosslyn's representational shift hypothesis, we too find a shift between 8 and 10 years of age in the ability of children to quickly access information that is not predominantly sensory in nature. Young readers appear to readily interpret words in terms of their sensory characteristics, whereas older children and adults rely on highly available general information from prior knowledge.

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